Machine Learning & Data Mining

Lecture 3

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Outline

- Multivariate Regression Model Building
- Polynomial Regression Model
- Support Vector Regression (SVR) Model

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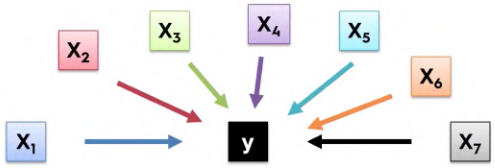
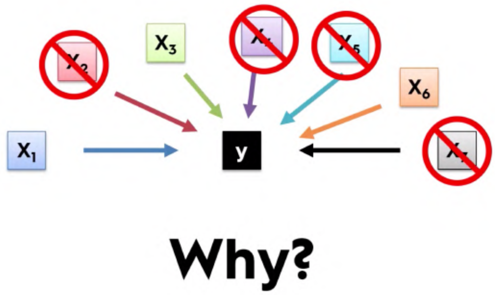
Building a Multivariate Regression Model

Building a Multivariate Regression Model

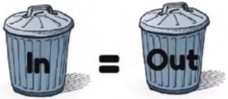


Building a Multivariate Regression Model



Building a Multivariate Regression Model

1)



2)

Building a Multivariate Regression Model

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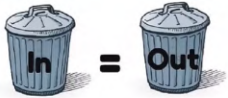
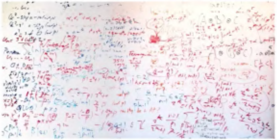


2)



Building a Multivariate Regression Model

5 methods of building models:

1. All-in

Building a Multivariate Regression Model

5 methods of building models:

1. All-in
2. Backward Elimination

Building a Multivariate Regression Model

5 methods of building models:

1. All-in
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3. Forward Selection

Building a Multivariate Regression Model

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4. Bidirectional Elimination

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5. Score Comparison

Building a Multivariate Regression Model

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Stepwise Regression

Building A Model

"All-in" – cases:

Building A Model

"All-in" – cases:

- Prior knowledge; OR

Building A Model

"All-in" – cases:

- Prior knowledge; OR
- You have to; OR

Building A Model

"All-in" – cases:

- Prior knowledge; OR
- You have to; OR
- Preparing for Backward Elimination

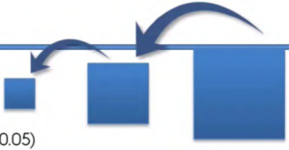

Building A Model
Backward Elimination

Building A Model

Backward Elimination

STEP 1: Select a significance level to stay in the model (e.g. SL = 0.05)

Building A Model



Backward Elimination

STEP 1: Select a significance level to stay in the model (e.g. SL = 0.05)

STEP 2: Fit the full model with all possible predictors

Building A Model

Backward Elimination

STEP 1: Select a significance level to stay in the model (e.g. SL = 0.05)

STEP 2: Fit the full model with all possible predictors

STEP 3: Consider the predictor with the highest P-value. If P > SL, go to STEP 4, otherwise go to FIN

Building A Model

Backward Elimination

STEP 1: Select a significance level to stay in the model (e.g. SL = 0.05)

STEP 2: Fit the full model with all possible predictors

STEP 3: Consider the predictor with the highest P-value. If P > SL, go to STEP 4, otherwise go to FIN

STEP 4: Remove the predictor

Building A Model

Backward Elimination

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STEP 5: Fit model without this variable*

Building A Model

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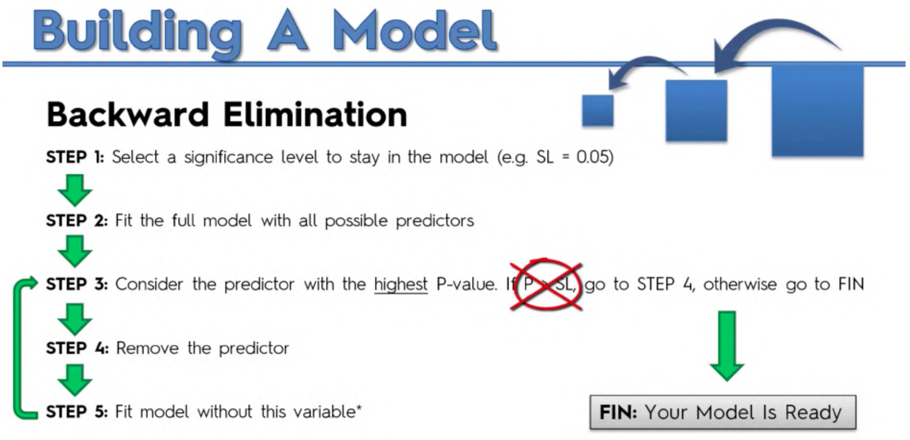
Building A Model
Backward Elimination
STEP 1: Select a significance level to stay in the model (e.g. SL = 0.05)
STEP 2: Fit the full model with all possible predictors
STEP 3: Consider the predictor with the highest P-value. If ~~P > SL,~~ go to STEP 4, otherwise go to FIN
STEP 4: Remove the predictor
STEP 5: Fit model without this variable*
FIN: Your Model Is Ready

Building A Model

Forward Selection

Building A Model

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STEP 1: Select a significance level to enter the model (e.g. SL = 0.05)

Building A Model

Forward Selection

STEP 1: Select a significance level to enter the model (e.g. SL = 0.05)

STEP 2: Fit all simple regression models **y ~ $\mathbf{x_n}$** Select the one with the lowest P-value

Building A Model

Forward Selection

STEP 1: Select a significance level to enter the model (e.g. SL = 0.05)

↓

STEP 2: Fit all simple regression models $\mathbf{y} \sim \mathbf{x}_n$ Select the one with the lowest P-value

↓

STEP 3: Keep this variable and fit all possible models with one extra predictor added to the one(s) you already have

Building A Model

Forward Selection

STEP 1: Select a significance level to enter the model (e.g. SL = 0.05)

⬇

STEP 2: Fit all simple regression models $\mathbf{y} \sim \mathbf{x_n}$ Select the one with the lowest P-value

⬇

STEP 3: Keep this variable and fit all possible models with one extra predictor added to the one(s) you already have

⬇

STEP 4: Consider the predictor with the <u>lowest</u> P-value. If P < SL, go to STEP 3, otherwise go to FIN

Building A Model

Forward Selection

STEP 1: Select a significance level to enter the model (e.g. SL = 0.05)

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STEP 3: Keep this variable and fit all possible models with one extra predictor added to the one(s) you already have

STEP 4: Consider the predictor with the lowest P-value. If P < SL, go to STEP 3, otherwise go to FIN

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Forward Selection

STEP 1: Select a significance level to enter the model (e.g. SL = 0.05)

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STEP 4: Consider the predictor with the lowest P-value. If ~~P < SL,~~ go to STEP 3, otherwise go to FIN

FIN: Keep the previous model

Building A Model

Bidirectional Elimination

Building A Model

Bidirectional Elimination

STEP 1: Select a significance level to enter and to stay in the model
e.g.: SLENTER = 0.05, SLSTAY = 0.05

Building A Model

Bidirectional Elimination

STEP 1: Select a significance level to enter and to stay in the model
e.g.: SLENTER = 0.05, SLSTAY = 0.05

STEP 2: Perform the next step of Forward Selection (new variables must have: P < SLENTER to enter)

Building A Model

Bidirectional Elimination

STEP 1: Select a significance level to enter and to stay in the model
e.g.: SLENTER = 0.05, SLSTAY = 0.05

STEP 2: Perform the next step of Forward Selection (new variables must have: P < SLENTER to enter)

STEP 3: Perform ALL steps of Backward Elimination (old variables must have P < SLSTAY to stay)

Building A Model

Bidirectional Elimination

STEP 1: Select a significance level to enter and to stay in the model
e.g.: SLENTER = 0.05, SLSTAY = 0.05

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Building A Model

Bidirectional Elimination

STEP 1: Select a significance level to enter and to stay in the model
e.g.: SLENTER = 0.05, SLSTAY = 0.05

STEP 2: Perform the next step of Forward Selection (new variables must have: P < SLENTER to enter)

STEP 3: Perform ALL steps of Backward Elimination (old variables must have P < SLSTAY to stay)

STEP 4: No new variables can enter and no old variables can exit

FIN: Your Model Is Ready

Building A Model

All Possible Models

Building A Model

All Possible Models

STEP 1: Select a criterion of goodness of fit (e.g. Akaike criterion)

Video on Akaike Information Criterion (AIC): https://www.youtube.com/watch?v=YkD7ydzp9_E

Building A Model

All Possible Models

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STEP 2: Construct All Possible Regression Models: 2^N-1 total combinations

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Building A Model

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STEP 2: Construct All Possible Regression Models: 2^N-1 total combinations

⬇

STEP 3: Select the one with the best criterion

⬇

FIN: Your Model Is Ready

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FIN: Your Model Is Ready

Example:
10 columns means
1,023 models

Building A Model

5 methods of building models:

1. All-in
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5. Score Comparison

Polynomial Regression Model

Regressions

Simple Linear Regression

$$y = b_0 + b_1 x_1$$

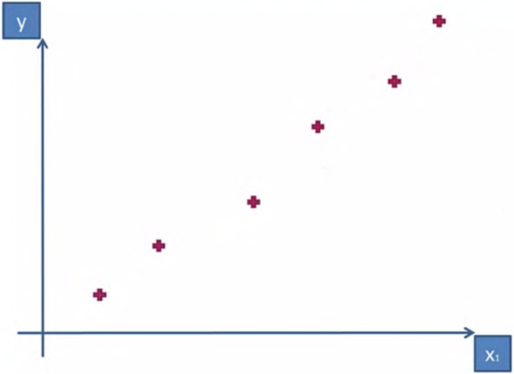
Regressions

Simple Linear Regression	$y = b_0 + b_1 x_1$
Multiple Linear Regression	$y = b_0 + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n$

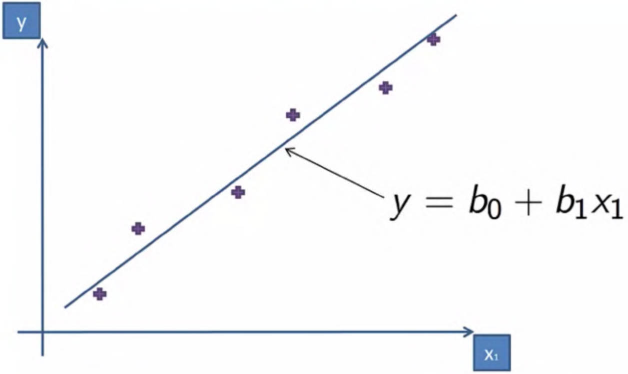
Regressions

Simple Linear Regression	$y = b_0 + b_1 x_1$
Multiple Linear Regression	$y = b_0 + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n$
Polynomial Linear Regression	$y = b_0 + b_1 x_1 + b_2 x_1^2 + \ldots + b_n x_1^n$

Simple Linear Regression



Simple Linear Regression



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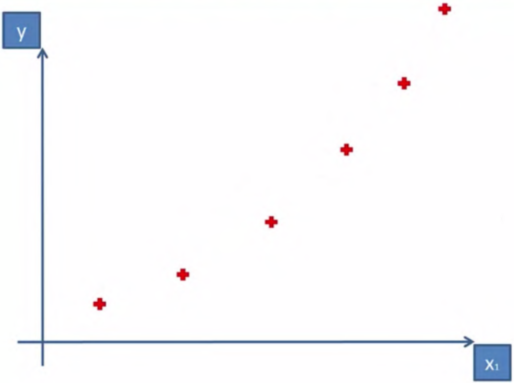
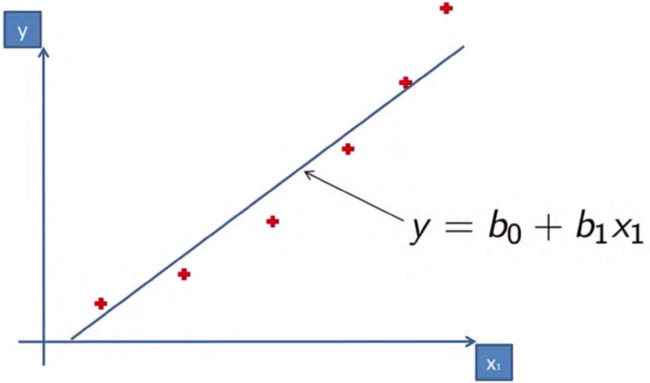
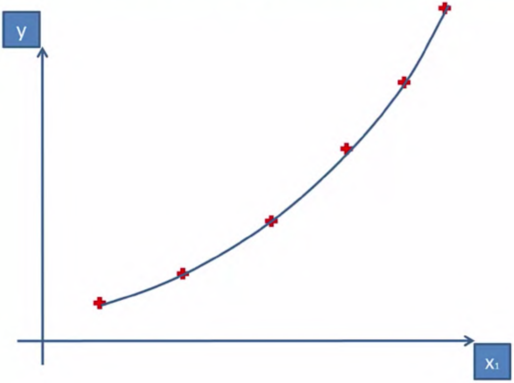


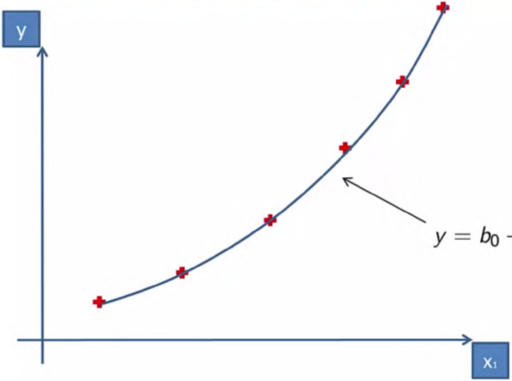
Simple Linear Regression



Polinomial Regression



Polinomial Regression



$$y = b_0 + b_1 x_1 \boxed{+ b_2 x_1^2}$$

Polinomial Regression

One Question: Why “Linear”?

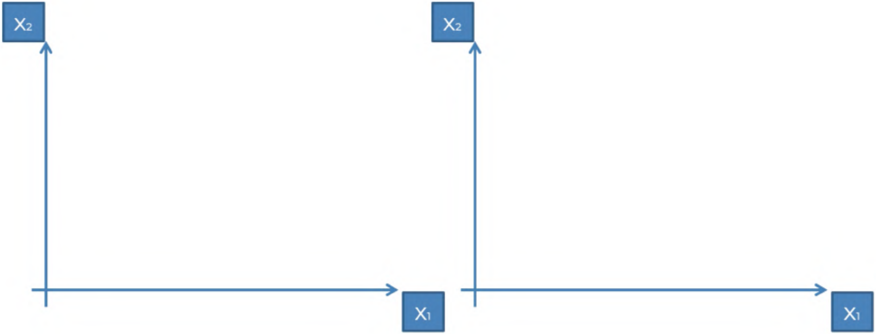
Polinomial Regression

Polynomial Linear Regression

$$y = b_0 + b_1 x_1 + b_2 x_1^2 + \ldots + b_n x_1^n$$

SVR Model

SVR Intuition



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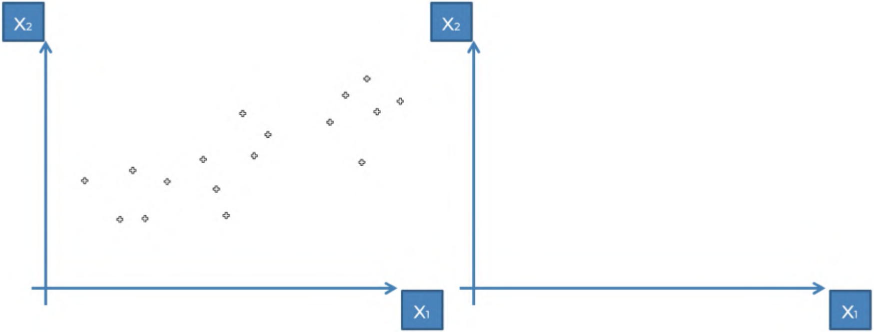

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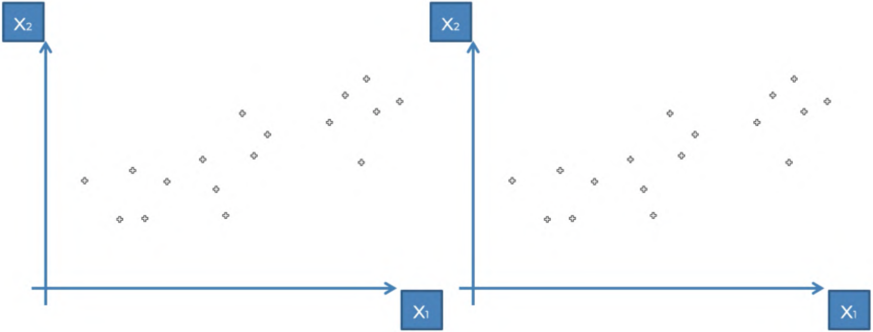

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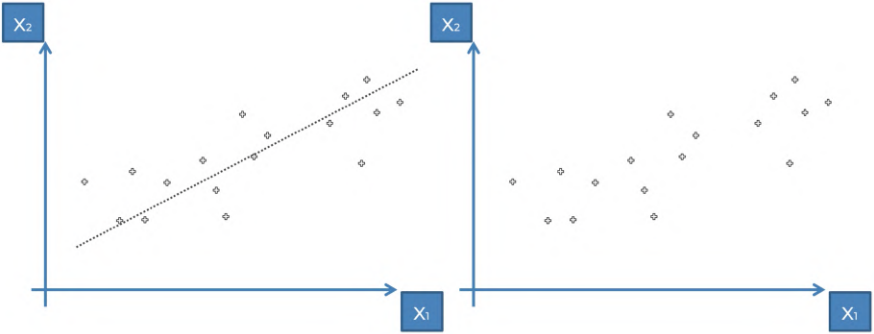

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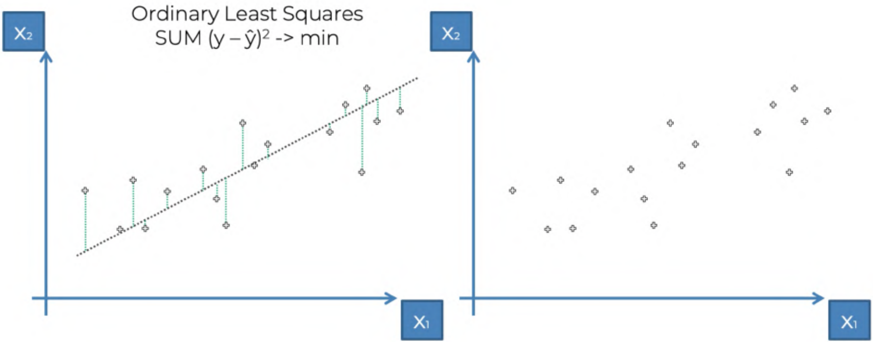

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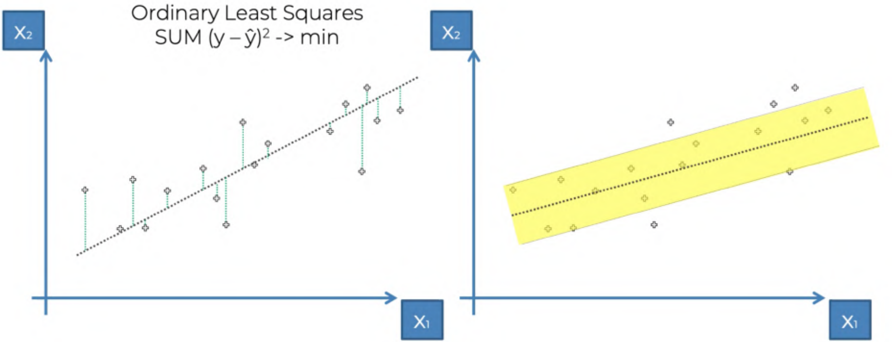

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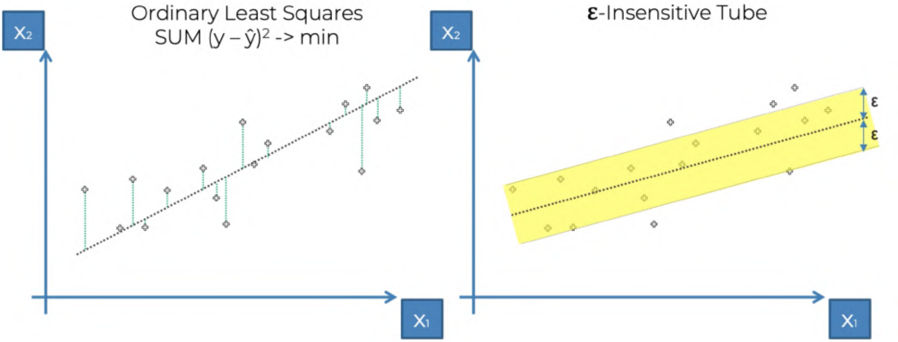

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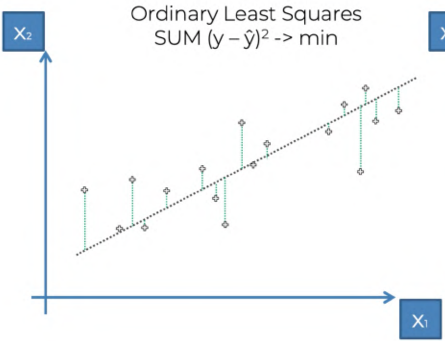

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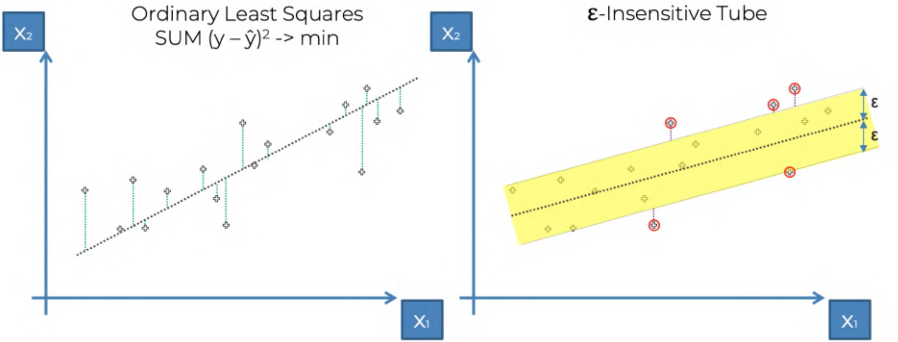

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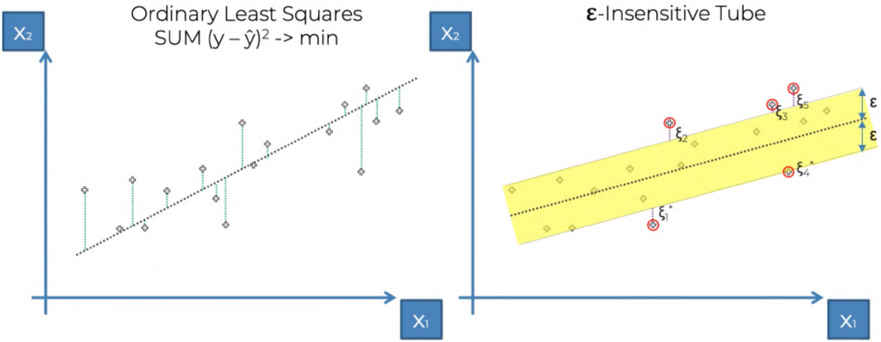

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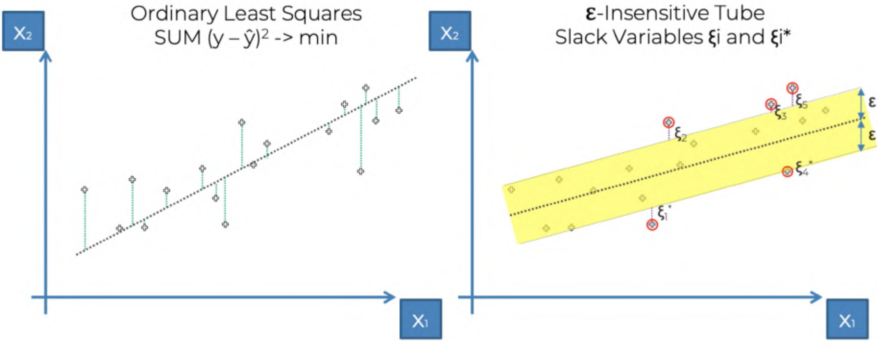
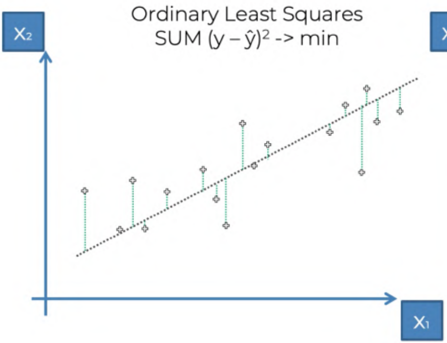
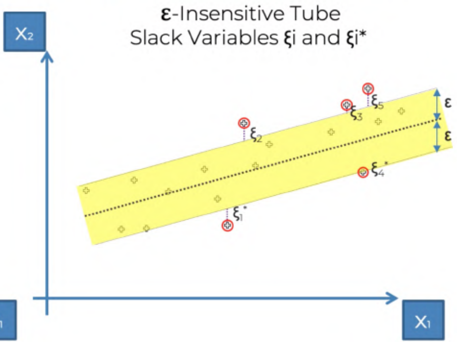


SVR Intuition

$$\frac{1}{2}\|w\|^2 + C\sum_{i=1}^{m}(\xi_i + \xi_i^*) \rightarrow min$$





SVR Intuition

Here is a link describing the SVR function minimization: https://towardsdatascience.com/an-introduction-to-support-vector-regression-svr-a3ebc1672c2#:~:text=SVR%20is%20a%20powerful%20algorithm,outside%20that%20acceptable%20error%20rate.

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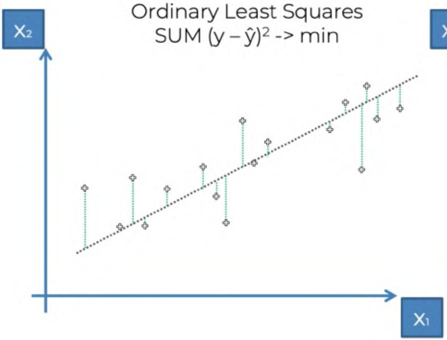

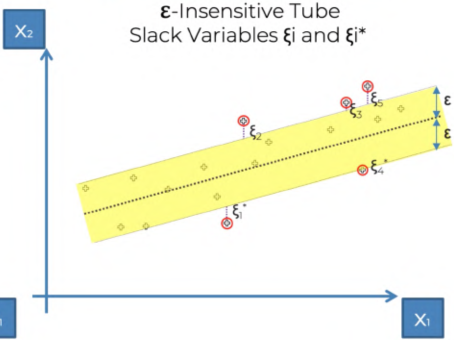

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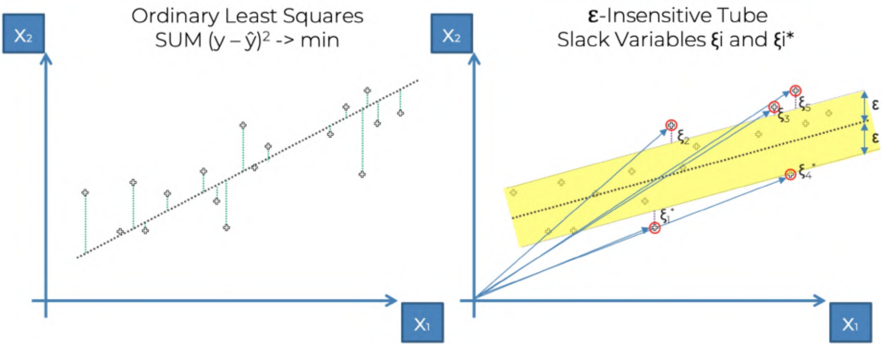


SVR Intuition

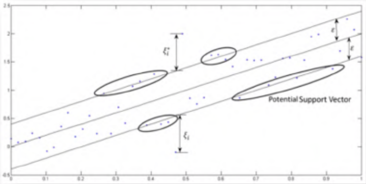
Additional Reading:

Chapter 4 – Support Vector Regression (from: Efficient Learning Machines: Theories, Concepts, and Applications for Engineers and System Designers)

By Mariette Awad & Rahul Khanna (2015)

Link:

https://core.ac.uk/download/pdf/81523322.pdf



Let's get Started!

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